

CLAIMS

- Sub A1
1. In an optical communication system, apparatus for amplifying an optical signal, said apparatus comprising:
- 5 a fiber;
- a first group of N optical pump energy sources disposed to propagate optical energy into said fiber in a first direction; and
- a second group of N+1 optical pump energy sources disposed to propagate optical energy into said fiber in a second direction opposite to said first direction; and
- 10 wherein N is greater than or equal to 1, Raman amplification is induced in said fiber, and said optical pump energy sources of said first group and said second group each have distinct pump wavelengths.
2. The apparatus of claim 1 wherein said pump wavelengths of said optical pump energy sources are selected to flatten an amplification response of said fiber across a desired frequency band.
3. The apparatus of claim 1 wherein neighboring pump wavelengths of said distinct pump wavelengths are associated with optical pump energy sources disposed to propagate in opposite directions.
- 20 4. The apparatus of claim 1 wherein said first direction comprises a direction of propagation of said signal through said fiber and said second direction comprises a direction opposite to said direction of propagation of said signal through said fiber.
- 25 5. The apparatus of claim 1 wherein said second direction comprises a direction of propagation of said signal through said fiber and said first direction comprises a direction opposite to said direction of propagation of said signal through said fiber.
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6. The apparatus of claim 1 wherein a first gain profile induced by said first group of optical pump energy sources and a second gain profile induced by said second group of optical pump energy sources compensate each other to provide a substantially flat total gain profile.

7. The apparatus of claim 1 wherein at least one optical pump energy source of said first group of optical pump energy sources and said second group of optical pump energy sources comprises a substantially depolarized optical pump energy source.

8. In an optical communication system, a method for amplifying an optical signal within a fiber by exploiting Raman effects, said method comprising:

injecting optical pump energy at  $N$  pump wavelengths into said fiber in a first direction; and

injecting optical pump energy at  $N+1$  pump wavelengths into said fiber in a second direction opposite said first direction; and

wherein  $N$  is greater than or equal to 1 and said  $N$  pump wavelengths and said  $N+1$  pump wavelengths alternate with one another in order of wavelength.

9. The method of claim 8 wherein said  $N$  pump wavelengths and said  $N+1$  pump wavelengths are selected to flatten an amplification response of said fiber across a desired frequency band.

10. The method of claim 8 wherein said first direction comprises a direction of propagation of said signal through said fiber and said second direction comprises a direction opposite to said direction of propagation of said signal through said fiber.

11. The method of claim 8 wherein said second direction comprises a direction of propagation of said signal through said fiber and said first direction comprises a direction opposite to said direction of propagation of said signal through said fiber.

12. The method of claim 8 wherein a first gain profile induced by injection of  
said N pump wavelengths and a second gain profile induced by injection of said N+1  
5 pump wavelengths compensate each other.

13. The method of claim 8 wherein injecting optical energy on at least one of  
said N pump wavelengths or N+1 pump wavelengths comprises injecting substantially  
depolarized optical energy.

14. In an optical communication system, apparatus for amplifying an optical  
signal within a fiber by exploiting Raman effects to achieve a desired gain level, said  
apparatus comprising:

means for injecting optical pump energy at N pump wavelengths into said fiber in  
a first direction; and

means injecting optical pump energy at N+1 pump wavelengths into said fiber in  
a second direction opposite said first direction; and

wherein N is greater than or equal to 1 and said N pump wavelengths and said  
N+1 pump wavelengths alternate with one another in order of wavelength.

15. The apparatus of claim 14 wherein said N pump wavelengths and said  
N+1 pump wavelengths are selected to flatten an amplification response of said fiber  
across a desired frequency band.

16. The apparatus of claim 14 wherein said first direction comprises a  
direction of propagation of said signal through said fiber and said second direction  
comprises a direction opposite to said direction of propagation of said signal through said  
fiber.

17. The apparatus of claim 14 wherein said second direction comprises a  
direction of propagation of said signal through said fiber and said first direction

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comprises a direction opposite to said direction of propagation of said signal through said fiber.

- 5            18.    The apparatus of claim 14 wherein a first gain profile induced by injection of said N pump wavelengths and a second gain profile induced by injection of said N+1 pump wavelengths compensate each other.

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